• E-mail: teleniuslowe@gmail.com

Pioneers of Radio – A Timeline

Steve Telenius-Lowe PJ4DX takes readers through a fascinating account of the early days of radio.

1800 Volta invents electric battery

1810

1820 Ørsted discovers electromagnetism

1830 Faraday demonstrates mutual inductance

1840

1850

1860 Maxwell predicts existence of radio waves
Loomis claims to transmit sparks over 22km

1870 Loomis predicts global radio transmission

1880 Hertz builds spark-gap TX
Lodge also builds spark TX

1890 Branly invents the coherer
Tesla forecasts radio tsmn
Lodge transmits sparks 55m
Marconi's first transmissions
Marconi transmits >2km
Popov's lightning detector RX
Bose demonstrates μwaves
Popov transmits ca 250m?
Marconi transmits >3km in UK
Bose describes 60GHz work
Tesla's radio-controlled boat

Everyone knows that Guglielmo Marconi invented radio. Or did he? Well, some Americans, Germans and Indians – and most Russians – would argue with that assertion. Certainly there were many others working around the same time who made their own contributions to what eventually developed into this wonderful hobby of ours. Well before Marconi, though, there were many other scientists without whose pioneering work it is unlikely that Marconi would have gone on to develop the practical use of radio in the way he did. We look at a timeline of the inventions, experiments and events that eventually led to the undisputed transmission of signals by radio waves.

The Early Pioneers

In **1820** Danish chemist and physicist **Hans Christian Ørsted** (1777 – 1851), fascinated with the 1799 invention by **Alessandro Volta** (1745 – 1827) of the 'Voltaic pile' (the first electric battery), was investigating the properties of electricity. In that year Ørsted showed that an electric current flowing through a wire produced a magnetic field, after observing that compass needles were deflected when electric current powered by a nearby battery was turned on and off. It was therefore Ørsted who discovered electromagnetism, yet today his name is virtually unknown, certainly in the UK.

In **1831** English physicist **Michael Faraday** demonstrated 'mutual induction' for the first time by showing that current could be induced in a coil when passing a current through an entirely separate coil, the two being wound around a ferrite toroid, **Fig. 1**. He also demonstrated that moving a magnet through a coil caused an electric current to flow.

Scottish mathematician and physicist **James Clerk Maxwell** followed up on Faraday's work and published *A Dynamical Theory of the Electromagnetic Field* in **1865**, for the first time postulating

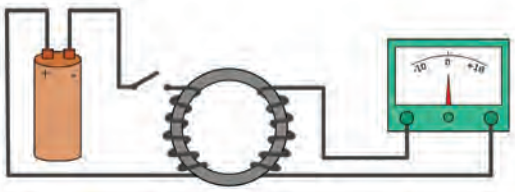


Fig. 1: Diagram of Faraday's equipment used for demonstrating mutual induction.

Michael Faraday (1791 – 1867), ca 1830, when he demonstrated mutual induction.

James Clerk Maxwell (1831 – 1879). Most photographs show him as a prematurely balding middle-aged man but this portrait was taken at Trinity College, Cambridge, when he was in his 20s.

Fig. 2: Hertz's 1887 spark-gap transmitter.

that electric and magnetic waves travel at the velocity of light. He also calculated the speed of light as 310,740,000 metres per second, not so very far from the figure we know today to be 299,792,458m/s (and usually rounded up to 300,000km/s when doing antenna length calculations, for example). Maxwell theorised that radio waves must exist, though it was left for others to prove that. Maxwell was a theorist and did little or no practical experimentation himself, yet his contribution to the understanding of physics was immense and he is regarded by many to be as influential as **Isaac Newton** before him and, later, even **Albert Einstein**.

Early American Claims

In **1864 Mahlon Loomis**, a Washington DC dentist, wrote in his journal that, *"I have been for years trying to study out a process by which telegraphic communications may be made across the ocean without any wires, and also from point to point on the earth, dispensing with wires."* **[1]**

In either **1866** or **1868** (the year is disputed, **[1]**, **[2]**) Loomis claims to have transmitted spark signals between the peaks of two mountains in Virginia that were no less than 22km apart. His 'Aerial Telegraph' system consisted of two kites, flown using 600ft (about 180m) of copper wire, above each mountain peak. Apparently, when the wire of one kite was grounded the spark generated was registered on a galvanometer connected to the other kite, 22km away. Loomis erroneously believed that he had somehow connected his kites into an electrically-conducting layer of the atmosphere. But, as the Southwest Museum of Engineering, Communications and Computation in Glendale, Arizona (quoting documents in the US Library of Congress) noted, sometimes the system worked, sometimes it seemed to depend on the height of one or both of the kites, and, *"There were days when the system just would not work at all"* **[2]**.

So did Loomis really transmit a spark signal over a distance of 22km? If so, it would have been at least 26 years earlier than Marconi's first transmissions over very much shorter distances. Or were the galvanometers simply registering the static electricity build-up on those long copper wires flown from the kites? This certainly seems the more plausible explanation, especially because on some days Loomis's system did not work at all – presumably those were clear days with little or no static. Over a hundred years earlier **Benjamin Franklin** had proposed his famous experiment of flying a kite in a storm in order to prove that lightning was a form of electricity and Loomis must have been aware of this.

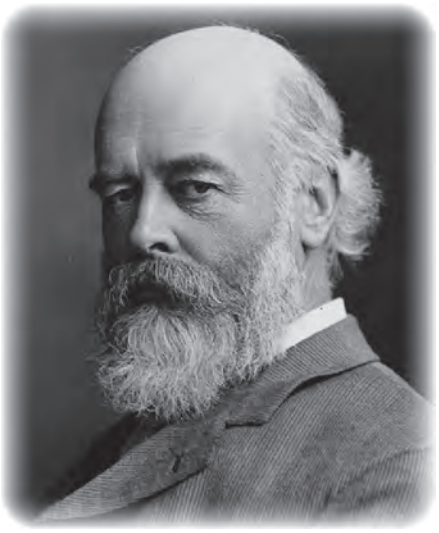
In **1872** another American, **William Henry Ward**, claimed that the atmosphere could be used to transmit signals like a telegraph wire, and was granted a patent on the *Improvement for Collecting Electricity for Telegraphing*. It is likely that he was aware of Loomis's experiments and was perhaps even a rival, because only a few months later Loomis was granted a very similar patent for *Improvements to Telegraphing*. Loomis was certainly not without ambition – in his patent application he made the then quite amazing claim of, *"utilising natural electricity and establishing an electrical current or circuit for telegraphic and other purposes without the aid of wires, artificial batteries, or cables to form such electrical circuit, and yet communicate from one continent of the globe to another"* **[1]**. If Loomis really had transmitted over a distance of 22km in the 1860s, it is inconceivable that, with his ambitious patents, he did not go on to exploit this feat. It is equally inconceivable that it would be three decades before anyone else achieved anything like the same results.

So Who Really Invented Radio?

A very good claim can be made that it was **Heinrich Hertz** who invented radio transmission. Born in Hamburg, Germany, Hertz built what could well be described as the world's first radio transmitter in **1887**, **Fig. 2**. He generated a high voltage by means of an induction coil that was fed to two copper wires each about 1m long, at the far ends of which were two zinc spheres. Thus Hertz also developed the first dipole antenna, which is why dipoles are still referred to as 'Hertzian antennas'. The zinc spheres were apparently used to bring the circuit to resonance by varying

Mahlon Loomis (1826 – 1886). Did he really transmit over 22km in the 1860s?

Heinrich Hertz (1857 – 1894) – the real inventor of radio?



Sir Oliver Lodge (1851 – 1940) (Photo: Lafayette Ltd / Wikipedia).

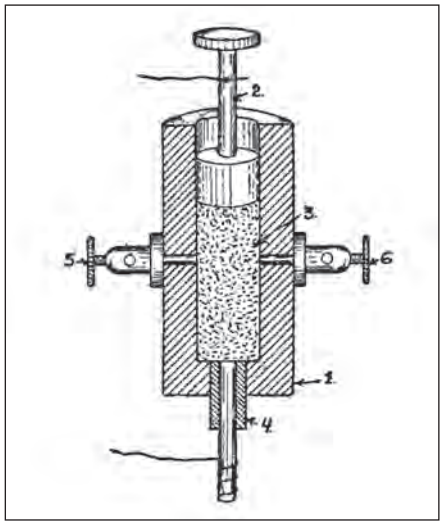


Fig. 3: The coherer, later developed by Sir Oliver Lodge, was invented in France by Édouard Branly.

Fig. 4: Villa Griffone, Marconi's family home near Bologna.

its capacitance but could also have been to prevent coronal discharge from the ends of the antenna. The centre of Hertz's dipole was separated by a small spark gap. Induction coils with secondary windings using as much as 10km of wire had earlier been developed by **Heinrich Ruhmkorff** and the enormous voltages generated could produce sparks up to 400mm long. While the sparks that Hertz generated would have covered a wide range of frequencies, the length of the antenna suggests that the peak radiation would have been somewhere around 75MHz, a wavelength of 4m.

Hertz's 'receiver' – placed just a few metres from the transmitter – was simply a loop of wire with a gap across which a spark formed when the transmitter was 'keyed'. Not only was Hertz the first to transmit the waves that Maxwell had theorised must exist but he was also able to measure them and demonstrate that the speed of radio waves was equal to the velocity of light, just as Maxwell had predicted.

Hertz famously did not recognise the importance of his discoveries. He is reported to have said, *"This is just an experiment that proves Maestro Maxwell was right. We have these mysterious electromagnetic waves that we cannot see with the naked eye but they are there."* When asked what use could be made of this phenomenon, or so the story goes, he replied, *"It's of no use whatsoever"* **[3].** Nevertheless, in **1888** Hertz wrote up his practical experiments in a technical journal.

The English physicist **Sir Oliver Lodge** had studied Maxwell's papers and, by **1879**, started investigating electromagnetic waves himself. In **1888** he carried out an experiment very similar to that of Hertz but using two 29m-long wires. It would appear that his discovery of what were termed 'Maxwell's electromagnetic waves' was made entirely independently of Hertz's the previous year. Later in 1888 he presented a paper on the generation of electromagnetic waves to the British Science Association in which he generously acknowledged Hertz's earlier work.

Some accounts (such as **[4]**) say that the 14-year old Guglielmo Marconi read Hertz's 1888 paper while on holiday in the Alps and rushed home to Italy to start experimenting. This seems unlikely but what seems certain is that Marconi was already interested in all things technical from a young age.

The 1890s

It was during the 1890s that radio experimentation, in France, America, Italy, Russia, India and England, really took off. **Édouard Branly**, born in Amiens, France, demonstrated what he called a 'radio conductor', **Fig. 3**, in **1890**. It was an early form of radio detector consisting of a tube containing metal filings between two electrodes. Branly's device was developed further and later renamed the 'coherer' by Oliver Lodge.

The Serbian-born American **Nikola Tesla**, although more famous for his work on alternating current, electric motors and his invention of the Tesla coil, was nevertheless also a radio pioneer. As early as **1893** he was giving lectures in cities

Édouard Branly (1844 – 1940), inventor of the coherer (Photo: Smithsonian Institution @ Flickr Commons).

Nikola Tesla (1856 – 1943), photographed in about 1896.

Guglielmo Marconi (1874 – 1937), a famous portrait.

Fig. 5: The IY4FGM QSL card, showing some of Marconi's early equipment.

across America about the possibility of transmitting radio waves.

In the spring and summer of **1894** Oliver Lodge presented a series of lectures about Hertz's work, demonstrating the transmission and reception of electromagnetic waves. Using a coherer, on August 14th 1894 he eventually increased the distance received to about 55m. However, he postulated that the maximum distance radio waves could be transmitted was half a mile (despite this miscalculation, or perhaps error of judgement, Lodge later became one of the first honorary members of the Radio Society of Great Britain).

Marconi's first recorded experiments also took place in the summer of **1894**, when he was 20 years old. He started by carrying out a reconstruction of Hertz's experiment of 1887 in the attic of his family's home, Villa Griffone, **Fig. 4**, 13km from Bologna. However, the distance he transmitted was considerably less than Lodge's 55m. It was not until the following year, **1895**, that he found his room was no longer large enough and he was obliged to move the receiver outdoors. In the spring of that year he transmitted signals from the Silkworm Room in Villa Griffone **[5]** to the other side of a hill in the grounds of the villa, a distance of under half a mile. At the time, it must have seemed as if Oliver Lodge's prediction was true. However, in August Marconi eventually transmitted over a distance of more than 2km using a vertical antenna tuned against ground, now known as a 'Marconi antenna'. The Marconi memorial special event station IY4FGM, located at Villa Griffone, shows some of Marconi's equipment on its QSL card, **Fig. 5**.

At almost the same time that Marconi was transmitting over a distance of about half a mile, **Alexander Popov** was experimenting with electricity at the St Petersburg naval academy in Russia. He built a device that used a coherer to detect the noise of lightning strikes and, on **May 7th 1895**, he presented a paper that described his apparatus. In Russia, Popov's device is considered to be the world's first radio receiver, despite the fact that Loomis was doing similar work almost three decades earlier in America. However, at that time Popov did not transmit radio waves, he merely received transmissions that had been made by Mother Nature. Nevertheless, to this day, May 7th is celebrated as 'Radio Day' in Russia.

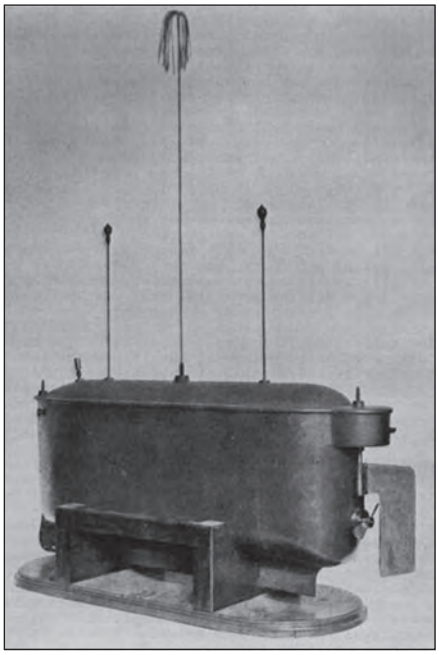


Fig. 6: Nikola Tesla's 1898 radio-controlled boat.

It would seem that Tesla was too busy working on the many new discoveries of the age – induction motors, arc lighting, X-rays, generating extremely high voltages to make artificial lightning and making a steam-powered electric generator – to concentrate on the development of radio transmission. However, in **1898** he built a radio-controlled model boat, **Fig. 6**, which he patented, and gave a public demonstration of it working in New York.

Alexander Popov (1859 – 1906), Russian physicist.

Jagadish Chandra Bose (1858 – 1937), here giving a lecture at the Royal Institution in London in 1897.

Jagadish Chandra Bose

While Lodge, Marconi and Popov were working in Europe, a remarkable series of experiments was being carried out in India by **Jagadish Chandra Bose**. Bose grew up in what is now Bangladesh and graduated at Calcutta (now Kolkata) before moving to England, where he assisted **John Strutt (Lord Rayleigh)**, the Cavendish Professor of Physics at the University of Cambridge. Bose returned to India, where he was appointed professor of physics at the University of Calcutta.

What was most remarkable about Bose's experiments was that they were carried out at frequencies of around 60GHz, about half a century before any further development took place at such short wavelengths!

In **1894** or **1895** (again, the year is unclear) he demonstrated microwave radiation by ringing a bell and igniting gunpowder using microwave radio waves at the town hall in Calcutta. He called

this phenomenon 'invisible light' and wrote, *"The invisible light can easily pass through brick walls, buildings, etc. Therefore, messages can be transmitted by means of it without the mediation of wires"*.

Bose returned to London for scientific meetings in 1896 and 1897 and it is known that he met Marconi there in **1896**. In **1897**, Bose presented a paper at the Royal Institution on his work at millimetre wavelengths. The paper described his experiments at 60GHz and the use of horn antennas, waveguides and an early form of semiconductor. Bose's 60GHz transmitter and receiver are on display at the Bose Institute in Kolkata, **Fig. 7**. The transmitter used an induction coil to provide a high voltage that generated a spark between 3mm metal spheres. The microwaves generated were transmitted from a waveguide and received by a galena crystal detector built inside a horn antenna.

It would seem that Bose, like Hertz before him, did not realise the far-reaching implications of his discoveries, being more interested in the purely scientific exploration of the new medium.

Back to Europe

In early **1896** Marconi moved to London and attempted to interest the GPO in the transmission of signals by radio. Meanwhile, in Russia, it is believed that Alexander Popov was able to transmit a signal between two buildings about 250m apart in **1896**, although accounts of the demonstration are sketchy and, anyway, by 1895 Marconi had already transmitted over a distance at least six times greater.

In **September 1896** there was a major success for Marconi while demonstrating radio to the British armed forces on Salisbury Plain, **Fig. 8**, when he successfully transmitted over a distance of about 3km. The rest, as the cliché goes, is history and it is well known that Marconi gradually increased the distances he transmitted, eventually spanning the Atlantic.

We started by questioning whether it was really Marconi who invented radio. A good case can be made to say that it was actually Hertz who 'invented' (in the strict sense of the word) radio transmission, in 1887. The distances he transmitted were so small, though, that he could perhaps be forgiven for his belief that his work had no practical value. But it was Marconi who first transmitted over a greater distance than it was possible to communicate by shouting and that, surely, was the real birth of radio.

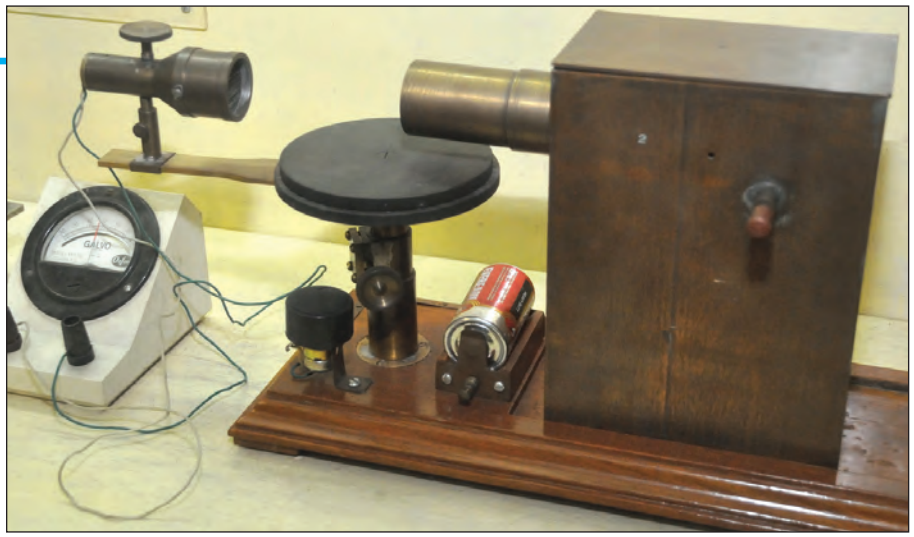


Fig. 7: Jagadish Bose's 60GHz spark-gap transmitter (right) on display at the Bose Institute in Kolkata. The metal tube on the left of the transmitter is a waveguide and Bose's microwave receiver is at the left the picture (the galvanometer and battery are modern replacements). (Photo: Biswarup Ganguly / Wikipedia).

Fig. 8: Marconi demonstrating radio to British armed forces personnel on Salisbury Plain, 1896.

PW readers of a certain age may remember the Radio Caroline and BBC Radio 1 DJ **Tom Lodge** (1936 – 2012). Tom's family had moved to Canada when he was young but on a visit to London when he was 28 he met **Ronan O'Rahilly**, who invited him to join Radio Caroline. In **April 1964** he became one of the first DJs on the station and was later its programme director. After the Marine Broadcasting Offences Act became law in **1967** Tom worked for a while on Radio 1. What has this to do with the pioneers of radio? Well, apart from the fact that Tom Lodge was certainly one of the pioneers of commercial radio in Britain, he just happened to be the grandson of Sir Oliver Lodge. From pre-radio times to the *Radio Times* after just two generations!

References

In addition to the relevant entries on *Wikipedia*, the following sources (as referenced in the text) were used in the research for this article:
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[5] IY4FGM qrz.com page: **www.qrz.com/db/iy4fgm**